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PROCESS FOR ALTERNATE CIRCUITING OF TRANSMISSION EQUIPMENT IN RING ARCHITECTURES FOR BIDIRECTIONAL TRANSMISSION OF ATM CELLS
[Verfahren zum Ersatzschalten von Übertragungseinrichtung in Ringarchitekturen zur bidirektionalen Übertragung von ATM-Zellen]

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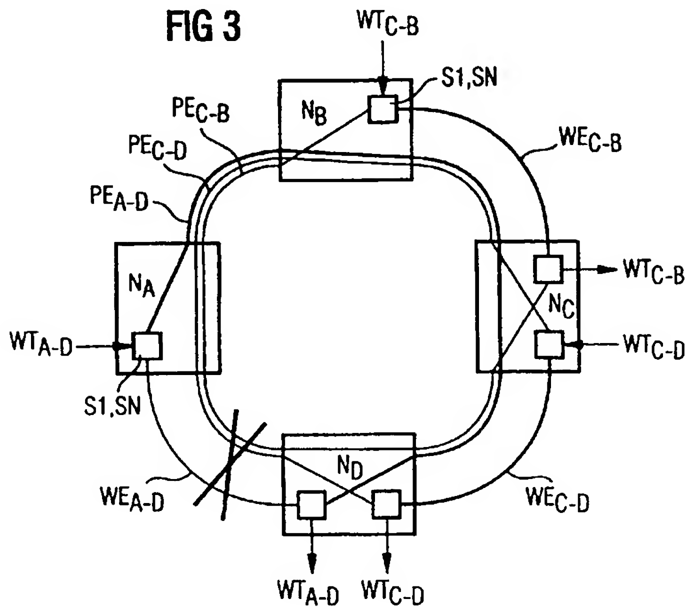
Alternate circuiting of ATM cells in the prior art is efficiently controlled using linear structures. In order to transfer these structures to ring architectures, as well, the present invention makes a ring structure from linear structures by linking additional linear structures into the transmission section of a linear structure and merging the switching devices of the original linear structure. Moreover, in accordance with the present invention, a plurality of protection entities share a common reserve transmission capacity. /1

FIG 3



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SPECIFICATIONS

This invention relates to a process in accordance with the precharacterizing part of Claim 1.

Such a process is previously known from German patent application DE 19646016.6.

This known method provides for transmission equipment for the bidirectional transmission of ATM cells in which two switching devices serving as terminal points are connected to each other via a plurality of working entities and the protection entity common to the working entities. Each of the two terminal points has one monitoring device per working entity for detecting transmission disturbances. A switching device that can be controlled by the monitoring device connects the transmitting terminal point to the working entity in a first switch state and to the protection entity in a second switch state. Control information is exchanged between the control devices of the two terminal points. Each switching device is controlled by the local monitoring device, depending on local control criteria and the control criteria contained in control information received from the remote location.

The disadvantage here is that this known method addresses only the alternate circuiting of transmission devices between two terminal

points. Since ring architectures are used particularly in a subscriber line network, this process cannot be used.

The object of this invention is to improve a method of the type mentioned at the outset in such a way that cells that are transmitted by an asynchronous transfer mode can be transmitted by a plurality of nodes with great reliability.

Based on the characteristics in the precharacterizing part of Claim 1, this object will be achieved by its characterizing part.

A particular advantage of the invention is that a plurality of protection entities share a common reserve transmission capacity. Advantageous refinements of the invention are presented in the dependent claims.

The invention will be explained below with the help of one embodiment.

It shows:

Figure 1: a configuration for bidirectional transmission of ATM cells in a linear 1:1 structure;

Figure 2: a ring configuration implementing the method of this invention;

Figure 3: the method in accordance with this invention in the case of a single error;

Figure 4: the method in accordance with this invention in the case of a double error.

Figure 1 shows two nodes of an ATM network, each of which is made as a switching device **W** and **E**. In this embodiment it is assumed that the switching devices are cross connect devices. However, the use of this type of equipment is not a limitation on the invention. Other types of switching devices may also be used. Figure 1 shows the transmission of ATM cells from switching device W to switching device E and vice versa. It is, therefore, a bidirectional connection.

The ATM cells are transmitted by an asynchronous transfer mode and each has a header part and an information part. The header part contains connection information and the information part contains useful information. The connection information contained in the header part is made in the form of logical information and is generally made as a virtual path number, VPI, or virtual channel number, VCI. A plurality of these virtual channel numbers, VCI, are combined, forming a virtual path number, VPI.

The switching devices **W** and **E** are linked together via working entities, which in the present embodiment are made in the form of a single working entity, $\mathbf{WE_1}$, and a protection entity, **PE**. Also shown are switching devices $\mathbf{S_0}$ and $\mathbf{S_1}$ (bridges), by which the incoming ATM

cells are transmitted optionally via working entity WE_1 or protection entity PE to switching device E.

Figure 1 also shows selection devices, **SN**, whose purpose is to carry the ATM cells transmitted by working entity WE_1 to the output of switching device **E**. In accordance with the present embodiment, selection devices **SN** are made in the form of an ATM switching network. Since this is a bidirectional connection, ATM switching network **SN** is contained in both switching device **W** and switching device **E**.

Moreover, both switching devices **W** and **E** show monitoring devices **ÜE**$_0$ and **ÜE**$_1$ (protection domain sink, and protection domain source), which monitor the state and quality of the ATM cells transmitted over working entity **WE**$_1$. For example, before passing across working entity **WE**$_1$ to switching device **E**, the ATM cells of the connection with the /3 number 1, **WT**$_1$, are provided with control information in monitoring device **ÜE**$_1$ of switching device **W**. This information is extracted and checked by monitoring device **ÜE**$_1$ of receiving switching device **E**. This control information can then be used to determine whether or not transmission of the ATM cell has been correct. In particular, a complete failure (signal failure for working entity) of working entity **WE**$_1$ can be detected. Additionally, however, conventional methods can be used to detect deterioration in the transmission quality (signal degrade). Monitoring devices **ÜE**$_1$ terminate working entity **WE**$_1$ at both

ends. Additional monitoring devices **$ÜE_0$** are arranged at either end of protection entity **PE**. In case of failure, this entity serves as a transmission path for working entity **WE_1**, which is put out of commission. In addition, alternate circuit protocols, **ES**, are transmitted by this path, so that the intactness of the protection entity is given the highest priority.

Central control units, not shown in Fig. 1, are also arranged in each of the switching devices **W** and **E**. Each of these contains local and global priority tables. The former stores the state and priority of the local switching device, while the latter contains the state and priority of both the local and the remaining switching devices. With the introduction of priorities, if there are several working entities and various alternate circuit requests occur at the same time, it is possible to determine which working entity is to be alternately circuited. The alternate circuit requests are also prioritized in the priority tables. There is, for example, a high priority request from a user. Since this alternate circuit request is given a high priority, it is controlled with priority. Consequently, an alternate circuit request from one of the working entities will be rejected.

The central control devices of switching devices **W** and **E** exchange information in an alternate circuit protocol, **ES**. This protocol is transmitted over protection entity **PE** and extracted by the corresponding monitoring device **$ÜE_0$** of the receiving switching device in question. It is then sent to the appropriate central control

device. The central control device also makes sure that in case of error switching devices S_0 and S_1 are controlled in the appropriate manner.

Protocol **ES** contains information on the instantaneous state of the switching devices. It also stores additional information on the alternate circuiting request that has been generated The protocol is exchanged between the two switching devices when an alternate circuiting request is generated. In a special embodiment of the invention, protocol **ES** is cyclically transmitted between the two switching devices.

In accordance with Fig. 1, the ATM cells are supplied to switching device **E** in the intact operating case. In this case, the ATM cells belong to connection WT_1. The individual connections are distinguished on the basis of the logical connection number, VPI, in the header part of the ATM cells.

In this operating state (still intact), switching devices S_0 and S_1 of switching device **W** are switched in such a way that the ATM cells are taken directly to monitoring device $ÜE_1$. Here, the ATM cells are provided with the above-mentioned control information and sent via working entity WE_1 to monitoring device $ÜE_1$ of the receiving switching device **E**. There the control information that has been sent is checked and any fault present is detected. If the transmission has been correct, the ATM cells are sent to the ATM switching network. Here, the logical connection information, VPI, is evaluated and, on the

basis of this evaluation, the ATM cell is sent on to the ATM network via the proper output of switching network **SN**.

During this time, protection entity PE may remain unused. If necessary, however, special data (extra traffic) can also be sent to switching device **E** during this time. Thus, switch $\mathbf{S_0}$ of switching device **W** takes assumes position 1 or 3. ATM cells are also used to transmit this special data. Monitoring device $\mathbf{ÜE_0}$ of switching device **W** supplies the ATM cells with control in formation in the same manner as described above in the case of working entity $\mathbf{WE_1}$. Control data of a general nature can be used as the special data. In accordance with this invention, the special data can also be special traffic data. For example, ABR (Available Bit Rate) or UBR (Unspecified Bit Rate) are possible traffic data, since the services that use these data are cost-effective.

It is assumed below that working entity **WE** has failed. This is reported by the associated monitoring device $\mathbf{ÜE_1}$ to the receiving switching device **E**. The alternate circuit request is now sent to the appropriate central control device, where it is placed in the local priority table and the global priority table.

In accordance with the priorities stored in the global priority table, it is now determined whether requests with even higher priority are waiting. This could be, for example, the switchover request of the user (forced switch for working entity) that has already been addressed. If no request of higher priority is present, then switch /4

S_1 of switching device **E** is switched to the remaining operating state, as shown in Fig. 1. Then the alternate circuiting protocol **ES** is sent via protection entity **PE** to switching device **W**. This alternate circuiting protocol contains the information previously mentioned. It is important to note that the local priority logic defines the form of the information with respect to the alternate circuiting request that is generated and the global priority logic defines the position of switch **S_0**.

Alternate circuit protocol **ES** is now received by monitoring device **$ÜE_0$** of switching device **E** and it is sent to the central control device of switching device **W**. If there are no additional requests of higher priority here in the global priority table, either, then switch **S_1** is controlled and switched in the proper manner here, as well. Switch **S_0** of switching device **W** is also switched over. The new status of the two switches **S_0** and **S_1** is acknowledged to switching device **E** and the global priority table there is updated. Thus, the ATM cells of connection **WT_1** are sent to switching device **E** via protection entity **PE**.

Figure 2 reveals a configuration in which the process in accordance with this invention is used. Here the switching devices are made in such a way as to form a closed ring. In the present

embodiment, the ring is made of linear connection sections, as shown in Fig. 1. As we know, this is the 1:1 structure.

Accordingly, a plurality of switching devices may be inferred from Fig. 2. They are switching devices $\mathbf{N_A}$, $\mathbf{N_B}$, $\mathbf{N_C}$, and $\mathbf{N_D}$. In each case, two of these switching devices terminate transmission sections. In the case of switching devices $\mathbf{N_A}$ and $\mathbf{N_D}$, these are working entities $\mathbf{WE_{A-D}}$ and protection entities $\mathbf{PE_{C-D}}$ and $\mathbf{PE_{C-B}}$. Similarly, the two switching devices $\mathbf{N_A}$ and $\mathbf{N_B}$ terminate the connection sections $\mathbf{PE_{A-D}}$, $\mathbf{PE_{C-D}}$, and $\mathbf{PE_{C-B}}$. In the latter case, as we know, these are assigned protection entities. In Fig. 2 (as in Figs. 3 and 4) the working entities are highlighted by thick lines, while the protection entities are indicated by a thin line.

Moreover, switches $\mathbf{S_1}$ and **SN**, which are identical to those in Fig. 1, may be inferred from all switching devices. For easier understanding, a detailed description in the sense of a division into S_1 and SN is dispensed with here. All the switching devices here also have a central control device (not shown) with local and global priority tables. Operation in the case of a linear device as in Fig. 1 has already been explained.

In accordance with the present embodiment, it is assumed that a connection $\mathbf{WT_{A-D}}$ is to be made between two subscriber terminal devices

by way of the ring. To accomplish this, the ATM cells belonging to this connection are sent to switching device N_A and sent by way of active working entity $\mathbf{WE_{A-D}}$ to switching device N_D, where the ATM cells belonging to connection $\mathbf{WT_{A-D}}$ leave the ring once again.

In Fig. 2 the direction in which these ATM cells enter and leave the ring is indicated by an arrow. However, since this connection is bidirectional, the ATM cells belonging to the return direction in question are sent over the same connection section. This means that the ATM cells belonging to the return direction are sent via switching device $\mathbf{N_D}$ into the ring and via connection $\mathbf{WE_{A-D}}$ to switching device $\mathbf{N_A}$, where they leave the ring. For the sake of clarity, however, only one direction is indicated description below.

The same applies to connections $\mathbf{WT_{C-B}}$ and $\mathbf{WT_{C-D}}$ in Fig. 2. The ATM cells belonging to the 3 connections $\mathbf{WT_{A-D}}$, $\mathbf{WT_{C-B}}$, and $\mathbf{WT_{C-D}}$ shown here are transmitted via the corresponding active working entities $\mathbf{WE_{A-D}}$, $\mathbf{WE_{C-B}}$, and $\mathbf{WE_{C-D}}$. Initially, the associated protection entities $\mathbf{PE_{A-D}}$, $\mathbf{PE_{C-B}}$, and $\mathbf{PE_{C-D}}$ remain unaffected.

Figure 3 now shows how a fault is handled by the process in accordance with this invention. This is done using the connection $\mathbf{WT_{A-D}}$ as an example. It is assumed that the transmission section between switching devices $\mathbf{N_A}$ and $\mathbf{N_D}$ is affected by a fault. It is further

assumed that this is initially the only fault in the ring. By exchanging alternate circuit protocol **ES** via protection entity $\mathbf{PE}_{\mathbf{A-D}}$, the fault is reported to switching device $\mathbf{N}_{\mathbf{A}}$. In accordance with an assessment of the local and global priorities, switch S of switching device $\mathbf{N}_{\mathbf{A}}$ is now switched to the remaining operating state. The ATM cells belonging to connection $\mathbf{WE}_{\mathbf{A-D}}$ are then sent via this protection entity $\mathbf{PE}_{\mathbf{A-D}}$ and switching devices $\mathbf{N}_{\mathbf{B}}$ and $\mathbf{N}_{\mathbf{C}}$ to switching device $\mathbf{N}_{\mathbf{D}}$, where they leave the ring.

In accordance with this invention, a common transmission capacity for the commonly used alternate path is reserved for connection sections between two switching devices. This is possible because it is assumed that only one transmission section of the ring is experiencing a fault. As an example, 140 Mbit/s each could be allocated to connections $\mathbf{WT}_{\mathbf{A-D}}$, $\mathbf{WT}_{\mathbf{C-B}}$, and $\mathbf{WT}_{\mathbf{C-D}}$. In this way, 140 Mbit/s would be allocated to all three protection entities between switching devices $\mathbf{N}_{\mathbf{A}}$ and $\mathbf{N}_{\mathbf{B}}$. This means that in the case of alternate circuiting of only one working entity 140 Mbit/s would be available on the allocated protection entity. Similar considerations apply to the transmission sections between switching devices $\mathbf{N}_{\mathbf{B}}$ and $\mathbf{N}_{\mathbf{C}}$. Similarly, 140 Mbit/s would be reserved here, whereby in the case of alternate circuiting of only one working entity on the allocated protection entity, a full

transmission capacity of 140 Mbit/s would also be available.

Such a procedure has the advantage, in particular, that fewer fees for transmission capacity need be reported. This would be different in the case of dedicated protection. The savings effect is most favorable in the case in which a connection between two neighboring switching devices is made. This is the case, for example, for the connection $\mathbf{WT_{A-D}}$ between switching devices $\mathbf{N_A}$ and $\mathbf{N_D}$. The savings effect is greatest here because the associated protection entities must pass through the other two switching devices, $\mathbf{N_B}$ and $\mathbf{N_C}$ to switching device $\mathbf{N_D}$. The same applies to the other connections that are shown, namely $\mathbf{WT_{C-D}}$ and $\mathbf{WT_{C-D}}$ [sic].

The savings effect relative to dedicated protection would be lowest if switching device $\mathbf{N_A}$ is made as switching level of a higher hierarchy level. In this case, all traffic of the other switching devices would have to be sent via this higher ranking switching device, $\mathbf{N_A}$.

A moderate savings effect would result if each of the switching devices would communicate with each switching device, in the sense of a complete intermeshing.

It is important to note that special data of a general kind, as explained in conjunction with Fig. 1, cannot be transmitted via the

ring. This refers, in particular, to the control data of a general kind discussed there. In accordance with this invention, however, the special traffic data made in the form of special data can be transmitted because their own priority is allocated to them. Examples include ABR (Available Bit Rate) or UBR (Unspecified Bit Rate) traffic data.

Finally, Fig. 4 shows another example of a fault scenario. Here, in addition to a single fault as in Fig. 3, there is an additional fault on connection path $\mathbf{WE}_{C-B}$. In this case, additional alternate circuiting protocols are exchanged. In this case, however, both the working entity and the protection entity are experiencing faults. Due to the common reservation of transmission capacity for protection entities, connections not affected by the fault would be affected by alternate circuiting of the two affected working entities to their respective protection entity. In the present case, this means connections $\mathbf{WT}_{C-D}$. Since switching would bring no advantage in this case, since the protection entity also affected by a fault, no switching is performed in the event of two faults.

Claims

1. A process for alternate circuiting of transmission devices in ring architecture for bidirectional transmission of ATM cells,

having

at least two switching devices (N_A and N_D) which terminate a transmission section formed by working entities (WE_{A-D}, WE_{D-A}) and/or (PE_{A-D}, PE_{D-A}) and between which information in ATM cells is sent via this transmission section whereby, in case of a fault on the transmission section in question, the ATM cells previously transmitted on said transmission section may be redirected if necessary to the protection entity, based on priority criteria and logical connection information,

characterized in that

additional switching devices (N_B and N_C) are linked to the transmission section and the at least two switching devices (N_A and N_D) are merged.

2. A process as recited in Claim 1,

characterized in that

a protection entity (PE_{A-D}, PE_{C-B}, PE_{C-D}) is assigned to each working entity (WE_{A-D}, WE_{C-B}, WE_{C-D}), whereby a plurality of protection entities can share a common reserved transmission capacity.

3. A process as recited in Claim 1 or 2,

characterized in that

in case of alternate circuiting, an alternate circuit request is

8. A process as recited in one of the previous Claims,

characterized in that

the switching device is made in the form of a cross-connect switching device.

9. A process as recited in one of the previous Claims,

characterized in that

the alternate circuiting may occur by activating a switch (S_1) in the transmitting switching device and by using a selection device (SN) in the receiving switching device.

10. A process as recited in one of the previous Claims,

characterized in that

special data may be transmitted over protection entity (PE) during fault-free periods of time.

11. A process as recited in the previous Claims,

characterized in that

special data is made in the form of ABR or UBR traffic data.

12. A process as recited in one of the previous Claims,

characterized in that

the selection device SN is made in the form of an ATM switching network and/or a simple switching element.

13. A process as recited in one of the previous Claims,

characterized in that

the alternate circuiting protocol is cyclically exchanged between the transmitting switching device and the receiving switching device.

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FIG 1

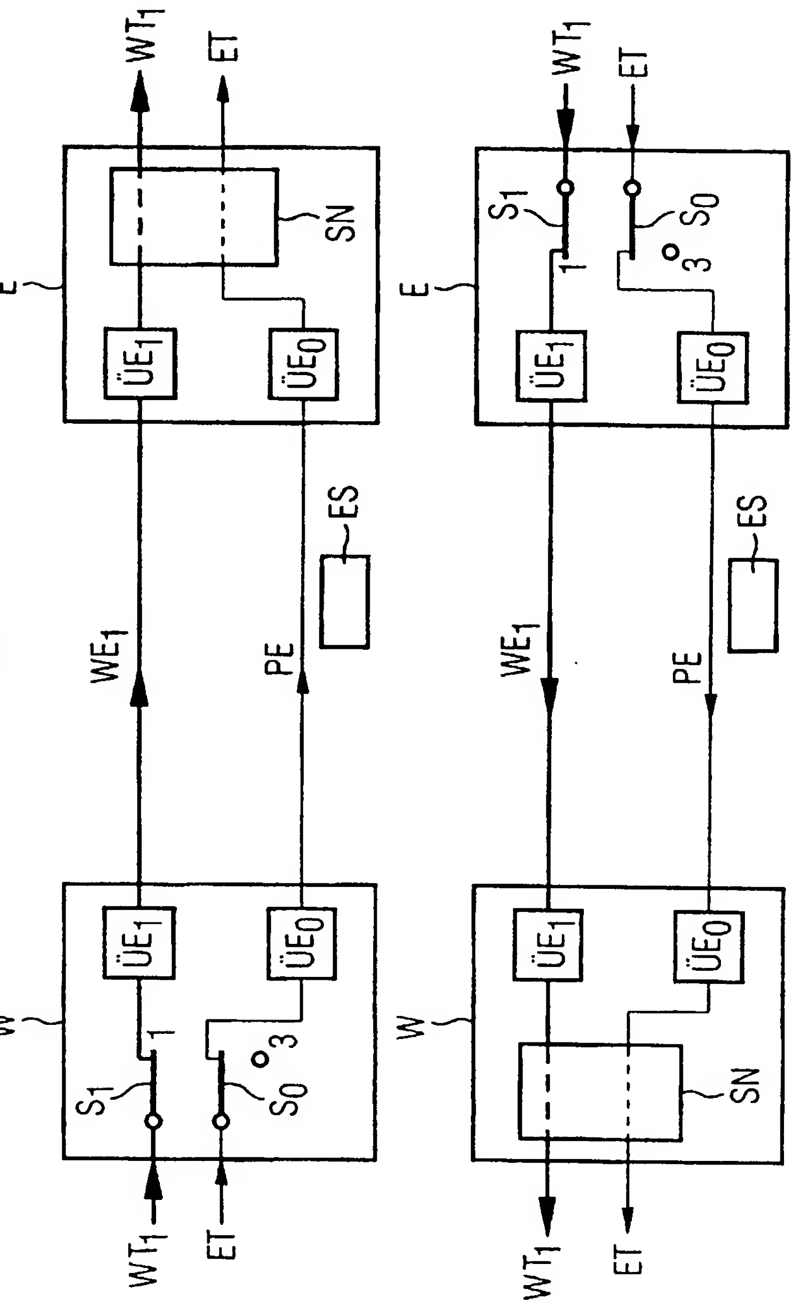

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FIG 2

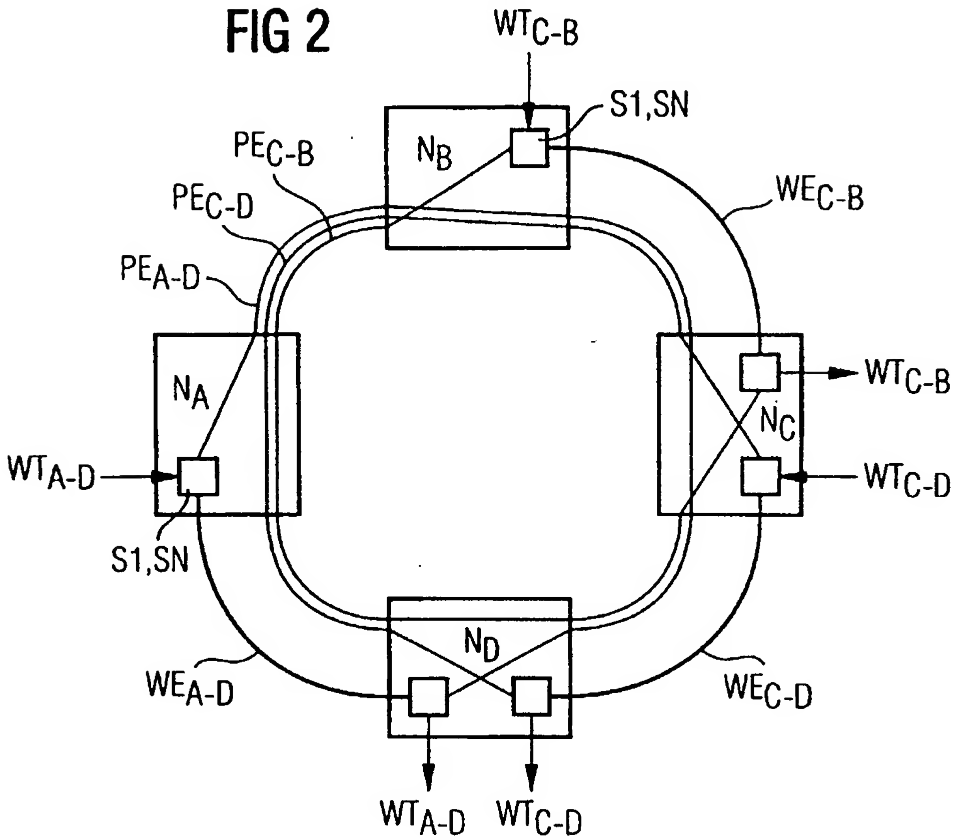
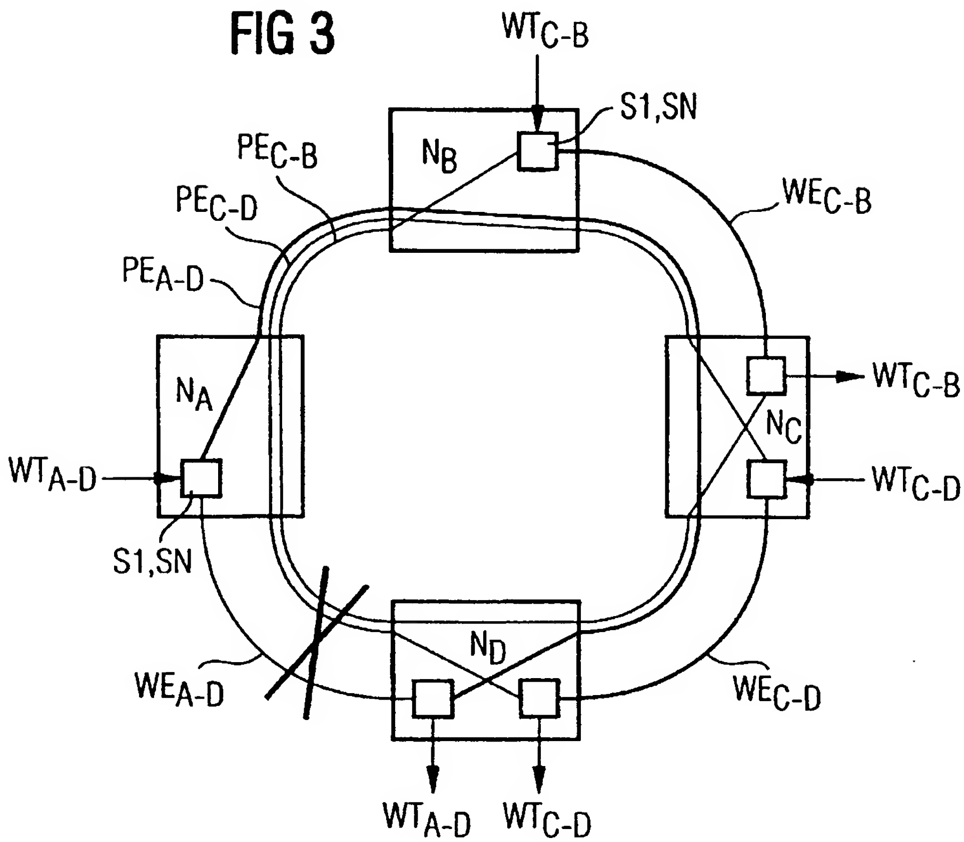


FIG 3



WTC-B
S1,SN
NB
PEC-B
PEC-D
PEA-D
WEC-B
NA
NC
WTC-B
WTA-D
WTC-D
S1,SN
ND
WEA-D
WEC-D
WTA-D
WTC-D

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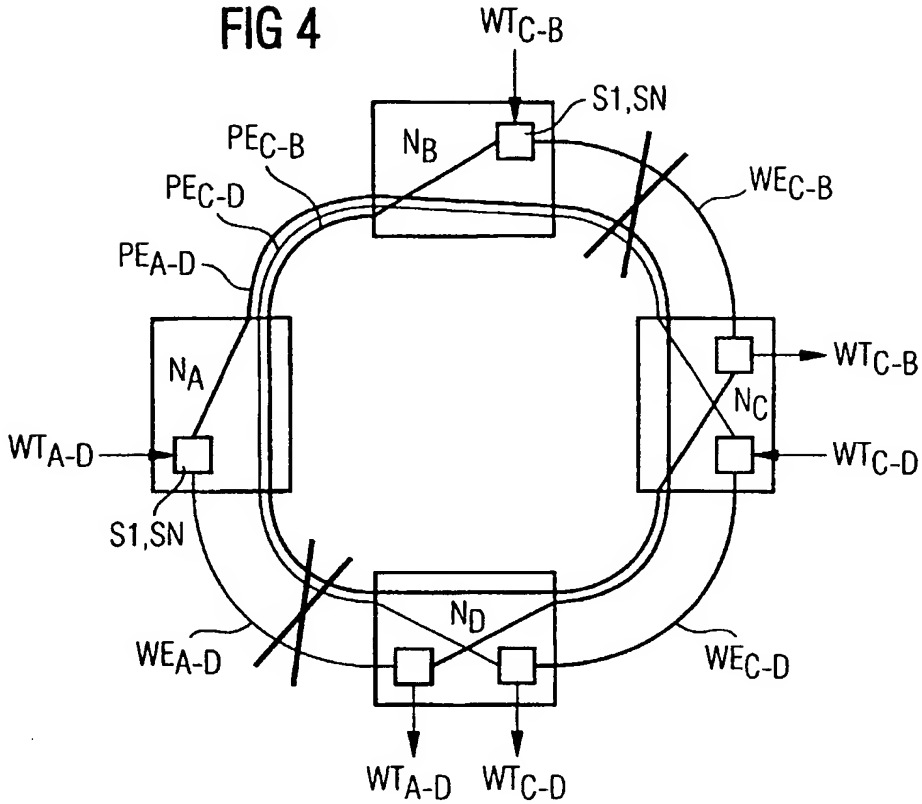
FIG 4



generated, to which additional priorities are allocated.

4. A process as recited in Claim 1,

characterized in that

the logical connection information is the number of a virtual channel (VCI) and/or the number of a virtual path (VPI) and/or the number of a virtual path group (VPG), which is formed from a plurality of virtual paths (VPI).

5. A process as recited in Claims 1 through 4,

characterized in that /6

local and global priority tables are provided in which the order of priority is determined.

6. A process as recited in one of the previous Claims,

characterized in that

when an alternate circuiting request arrives, an alternate circuiting protocol is generated in the receiving switching device and is sent only once to the sending switching device via the protection entity (PE).

7. A process as recited in one of the previous Claims,

characterized in that

total loss or degradation of a working entity is detected in the monitoring device of the receiving switching device.